TECHNICAL SOLUTIONS FOR CUTTING & GRINDING

IN THE PRIMARY STEEL MARKET

TECHNICAL GUIDE

NORTON®
SAINT-GOBAIN

™

TECHNICAL SOLUTIONS FOR PRIMARY STEEL MARKET

From initial steel conditioning to grinding, finishing and polishing of sheets, bars or tubes, whether cutting slabs, billets and bars or re-grinding rolls to the highest surface quality, Saint-Gobain provides the optimum abrasive solution for every application.

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CONTENTS

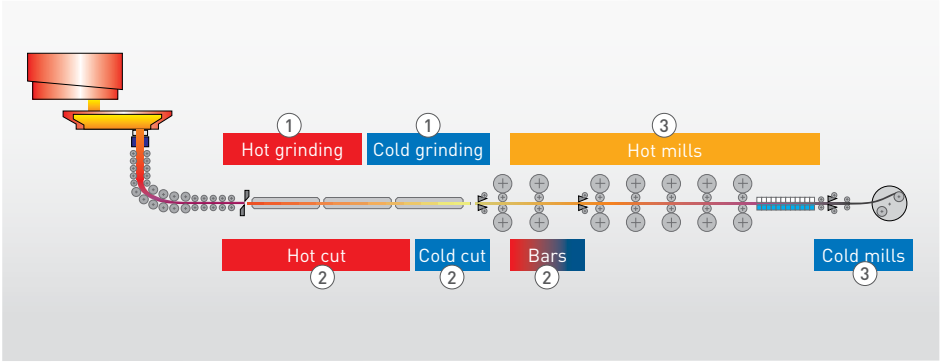
STEEL MANUFACTURING

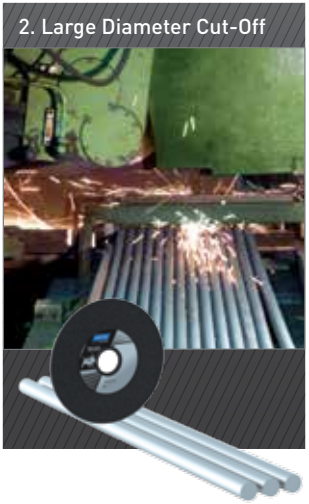
Today more than 1.4 billion tons of steel are produced every year. It is a major component in the manufacturing of buildings and infrastructures, machines, tools and transportation. Modern steel is identified by grades. Its processing from ore to semi-finished materials such as slabs, ingots and plates undergoes the same steps.

INTRODUCTION

To become steel, iron is melted and re-processed to reduce the carbon content and add other chemicals. This liquid is then continuously cast into long slabs or ingots. The ingots are heated in a soaking pit and hot rolled into slabs.

The diagram below shows the grinding and cutting application stages involved in steel production:





MATERIAL CLASSIFICATION

	CAST IRON		STEEL				OTHER MATERIALS		
Material family	Cast iron grey (2.5-4% C)	Ductile/ nodular cast iron	Carbon steel soft (<1.3% Carbon)	Carbon steel hard (<3.4% Carbon)	Stainless & alloy steel	Tool steel	Nickel alloy	Titanium	Aluminium
Density range	7.1-7.3	6.6-7.2	7.7-8.1	7.8-8.3	7.7-9	6.5-8.2	8.2-8.9	4.5	2.7
Hardness	180-300 HB	130-220 HB	86-580 HB	170-600 HB	80-600 HB	140-750 HB	140-513 HV	70 HB-60HV	15 HV
Application	Engine gears	Gears, camshafts, crankshaft	Various general engineering				Aerospace, sport, military, automotive.		
High / Grindability Index / Low	Cast iron		Steel				Other materials		

The graph above shows the grindability index for each material family. The grindability index is defined as the measure of how easy or hard a material is to grind under specified conditions. It is expressed in volume of material removed per unit volume of wheel wear.

OUR COMMITMENT: SAFETY, QUALITY AND ENVIRONMENT PRESERVATION

SAFETY

The personal safety of workers using abrasive cutting and grinding wheels is our primary concern. All Norton abrasive wheels are developed, manufactured and safety tested in accordance with the European standard EN12413, safety requirements for bonded abrasive products. In addition, all Norton products meet stringent requirements of the Organization for the Safety of Abrasives (oSa). Saint-Gobain Abrasives is a founding member of the oSa organisation.

FEPA
www.fepa-abrasives.org

oSA®
www.osa-abrasives.org

QUALITY

Saint-Gobain Abrasives is fully ISO accredited:

ISO 9001: certifies Quality Management system is in accordance with requirements of quality standards.

ISO 14001: certifies Environmental Management system is in accordance with requirements of environmental standards.

OHSAS 18001: health and safety at work certification.

ENVIRONMENTAL PRESERVATION

Environmental Protection
Waste management is undertaken to optimise recycling activities and zero pollution of air, water and land is defined as a major objective.

Reduction of Natural Resource Consumption
New production processes and procedures are regularly implemented to help minimise the amount of waste created during the manufacturing process.

STEEL CONDITIONING (BZZ)

In steel conditioning processes, hot pressed, very hard wheels without porosity, are commonly used to eliminate defects (cracks, impurities and straws) from slabs, blooms, billets and ingots.

INTRODUCTION

Before further processing semi-finished steel products, the workpiece should be free from scale and flaws. High-pressure grinding is the optimal process for removing scale, cracks and other surface defects. Grinding large-scale rounded parts however, requires specific grinding facilities. Machines generally have extremely high driving power, between 50 and 630 kW. The grinding speed is generally 80 m/s.

Grinding processes can be optimized, enhancing quality and reducing costs by:

- Removing defects and cracks at lower cost
- Ensuring the best surface quality for downstream processes
- Minimizing metal waste at the conditioning stage

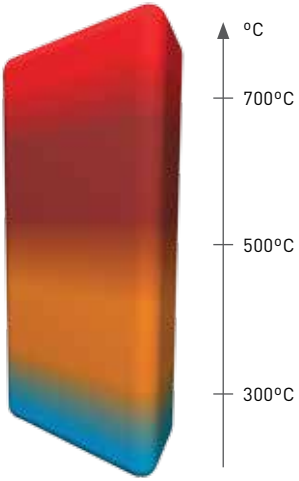
Three key process characteristics will dictate the choice of wheel specification:

- Temperature of the material to be ground
- Material characteristics
- Features of the machine or pressure applied during grinding

WORKPIECE TEMPERATURE

After casting, the steel is cut into slabs, billets or blooms. Steel conditioning with hot-pressed wheels is carried out with cold, warm or hot workpiece temperature to remove scale, eliminate defects, and achieve the required surface finish.

WORKPIECE TEMPERATURE	
Red hot grinding	Above 700°C
Hot grinding	500-700°C
Warm grinding	300-500°C
Cold grinding	Up to 300°C



MATERIAL CHARACTERISTICS

The characteristics and shape of the material dictate the choice of grinding wheel specification.

Steel mills:

- Carbon steel - used for springs and bearings
- Low, medium and high alloyed steels
- Stainless steel - austenitic, ferritic martensitic and duplex
- Refractory steels - titanium, zirconium and nickel
- Slabs, billets, ingots, blooms, rounds

Foundries (roll manufacturers):

- Roughing rolls - work and back up
- Spin cast high chrome, high speed steel

MACHINE CHARACTERISTICS

Typical machine features:

- Power ranges from 50 to 630 kW
- Medium to high stiffness

Typical metal removal:

- 3 to 15 kg/s/mm
- 2 to 7 kg/kWh (on stainless steel)

Application

- Cold grinding
- Warm grinding
- Hot grinding

Machine

- Low power (120 kW and below)
- Medium power (120 - 250 kW)
- High power (250 kW and above)

Material

- Stainless steel
- Carbon steel
- High alloy steel
- Titanium

Requirements

- Yield loss
- Surface finish
- Life

PRODUCT CHARACTERISTICS

DIMENSIONAL AVAILABILITY

DIAMETER (mm)	THICKNESS (mm)	BORE (mm)	MOQ
406	38-51-63	152.4	10
508	51-65	152.4-203.2	5
610	51-65-76-102-127	203.2-304.8-305	5
760	76-102-125	203.2-304.8-305	2
915	102-125-150	304.8-305-400	2

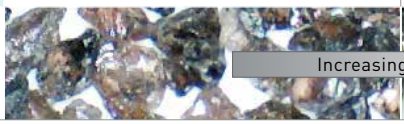
PRIMARY ABRASIVE GRAINS

Different grain qualities are available to meet various grinding needs.

BZZ Code	300Z	400Z	500A	600A	700A
Description	Sharpened zirconia aluminium	Blocky zirconia aluminium	Sintered bauxite	Sintered aluminium oxide	Sintered bauxite
Cutting (MRR)	++	+	++	+++	+++
Wheel life	++	+++	+	++	++
Surface finish	- -	- -	+	+	+
Grit size	6 – 30	8 – 30	10 - 30	10 - 24	12 - 24
					

+ Denotes performance rate

CONVENTIONAL ABRASIVE GRAINS

BZZ Code	100A	200C
Description	Fused aluminium oxide	Silicon carbide
Grit Size	8 - 60	10 - 60
		

TOP TIP

700A grain is an efficient alternative to 500A, bringing increased productivity on stainless steel grinding applications. 700A has excellent free cutting performance, providing higher material removal rates at lower pressures, generating less heat. It is the perfect solution for stainless steel grinding.

ABRASIVE BLENDS

Abrasive grains can be combined to provide optimum results. Grain combinations are made up of a series of numbers and a letter:

4	7	5	Z
1st abrasive	2nd abrasive	Blend of 2nd abrasive	Grain code
1:100A	0: no blend	0	A: If first digit = 1,5,6,7
2: 200C	1: 100A	1	C: If first digit = 2
3: 300Z	2: 200C	2	Z: If first digit =3,4
4: 400Z	5: 500A	5	
5: 500A	6: 600A	7	
6: 600A	7: 700A		
7: 700A			

Increasing content

GRIT SIZE COMBINATION

The grit size combination is the nominal grit size and the combination code: **14** **4**

Nominal Grit	COMBINATION			
	1 (100%)	2 (33%-33%-33%)	4 (50%-50%)	5 (60%-20%-20%)
8	8	6-8-10	8-10	6-8-10
10	10	8-10-12	10-12	8-10-12
12	12	10-12-14	10-12-14	10-12-14
14	14	12-14-16	14-16	12-14-16
16	16	14-16-20	16-20	14-16-20
20	20	16-20-24	20-24	16-20-24
24	24	20-24-30	24-30	20-24-30
30	30	24-30-36	30-36	24-30-36
36	36			

The grit size is measured in Mesh.
The coarser the grain, the higher the MRR (Material Removal Rate) and the G-Ratio (wheel efficiency).

WHEEL MARKING

Norton BZZ manufacturing specification: Example: 700A144XBZZ

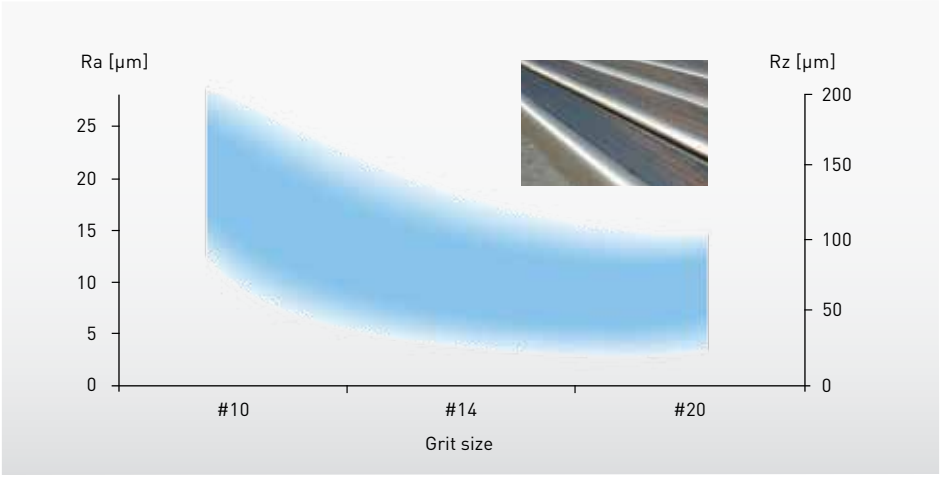
The table below shows an example of wheel marking conversion from the manufacturing code: 700A144XBZZ to the commercial specification:

	ABRASIVE TYPE	GRIT SIZE	COMBINATION	GRADE	BOND
Manufacturing	700A	14	4	X	BZZ
Commercial	A	14	-	X	BZZ

All Saint-Gobain Abrasive's wheels are marked in compliance with the International Standard ISO 525.

SURFACE FINISHING

Surface finish achieved depends on machine condition, steel grade, operating conditions and abrasive wheel specification. The graph below shows the expected surface finish generated depending on grit size selected.

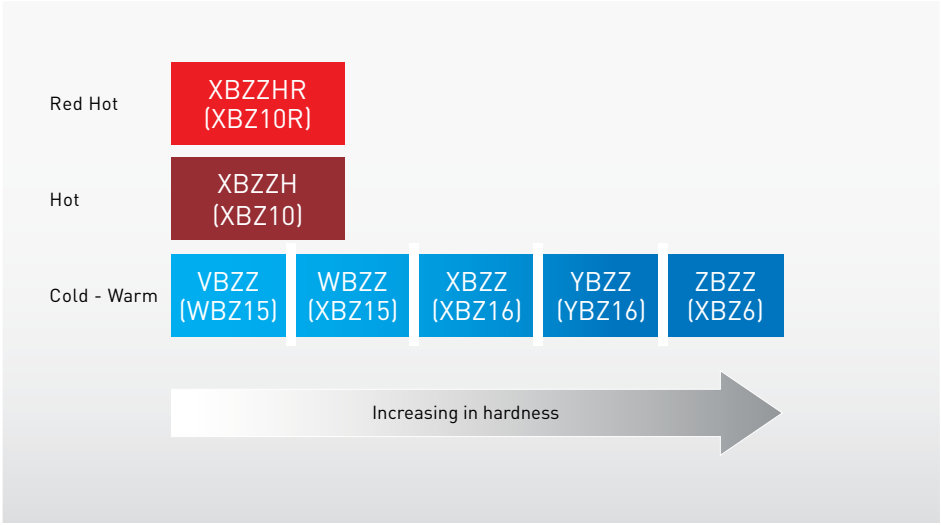


IDENTIFICATION & TRACEABILITY

Each wheel provided by Saint-Gobain Abrasives is identified by a unique marking containing all information about the production of the wheel.

BOND AVAILABILITY

Bond is selected depending on machine straightness, material grindability and metal temperature.



TOP TIP

For high stress grinding applications use XBZZE bond (similar hardness to XBZZ).
For better resistance to cracks, use the "R" bond modification. (e.g. XBZZER)

PRODUCT SELECTION GUIDE

Workpiece Temperature	Cold - Warm		Hot	
Application	High Pressure	Low Pressure	High Pressure	Low Pressure
Carbon steel	400Z104YBZZ	312Z124WBZZ	475Z124XBZZH	375Z144XBZZH
Inconel	400Z164XBZZ	312Z164WBZZ	475Z164XBZZH	375Z164XBZZH
Stainless	700A144XBZZ 700A144XBZZE	700A164WBZZ	700A144XBZZH	700A164XBZZH
Low and medium alloy	472Z144XBZZ	372Z164WBZZ	472A144XBZZH	372A144XBZZH
Titanium-zirconia	300Z85WBZZ	327Z105VBZZ	372A104XBZZH	372A124XBZZH
High alloy steel	300Z124XBZZ	325Z144VBZZ	300Z144XBZZH	325144XBZZH
Roll manufacturer	322Z84XBZZER	325Z14VBZZ		

APPLICATION GUIDELINES

The following variables can influence the grinding application:

Machine:

- Machine type
- Power
- Operating speed
- Machine controls & condition
- Angle of tilt

Work piece:

- Part cross section
- Part conditions
- Grindability of material
- Desired finish
- Depth of defect
- Quality of casting/pouring

Grinding Wheel:

- Wheel size
- Hardness grade
- Type of abrasive
- Grit & size
- Structure & bond

Operating condition:

- Pressure
- Cross feed
- Rate of table travel
- Area of contact
- Power drawn

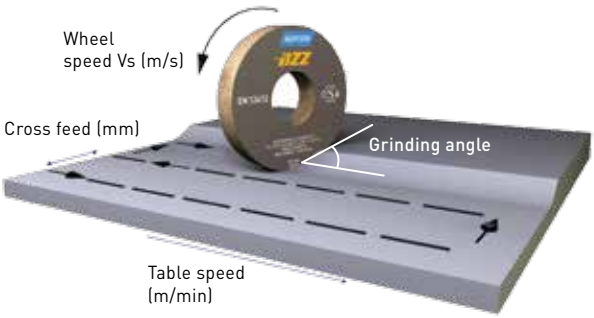
Material Removal Rate = material removed/grinding time [kg/h]

Wheel Wear Rate = wheel wear / grinding time [kg/h] or [dm³/h]

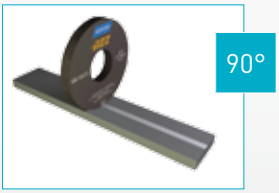
Grinding Ratio = material removed/wheel wear [kg/dm³]

Q-ratio = material removed/ wheel wear [kg/kg]

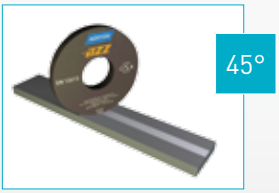
Yield loss = material removed of material weight in ‰



GRINDING ANGLE COMPARISON



- Minimum grinding wheel wear
- Good surface roughness
- Minimum corner breakdown



- Optimum Material Removal Rate (MMR)
- Increase grinding path width
- Reduce scallop effect (less over grinding)

TROUBLESHOOTING

EFFECT OF INCREASING PERIPHERAL WHEEL SPEED (V_S)

POSITIVE EFFECT	NEGATIVE EFFECTS
Reduced wheel wear	Increased grinding heat & energy consumption
Improved surface finish	Increased vibration
Increased MMR	Higher wheel stresses
Increase grinding ratio (MR/WW)	Increased machine stresses

TOP TIP

Usual, maximum and optimal wheel speed is 80 m/s. On constant RPM machines, the peripheral wheel speed decreases.

INCREASED FORCE	REDUCED FORCE
Increases wheel wear rate	Improves surface finish
Increases metal removal rate	Reduces depth of cut
Increases power required	Reduces yield loss

TOP TIP

Steel conditioning can be performed on constant load or constant power (following machine feature and/or programming). On constant power MRR is more controlled.

INFLUENCE OF THE TABLE SPEED

Typically, table speed is between 30 and 60 m/min.

INCREASE TRAVERSE RATE	DECREASE TRAVERSE RATE
Reduce grinding power	Increase depth of cut
Reduce wheel wear rate	Increase metal removal rate
Increase vibration/chatter	Increase heat generation
Better surface finish if no chatter	-
The wheel acts harder	The wheel acts softer

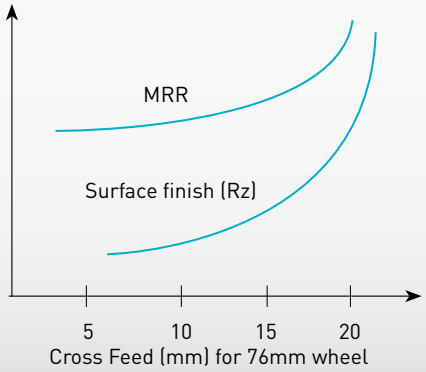
EFFECT OF THE WHEEL SIZE

LARGER DIAMETER	LARGER THICKNESS
Increased contact area	Increased contact area
Wider grinding path	Wider grinding path
Lower cost per dm^3 wheel	Higher wheel stresses
Increase surface area for energy absorption	Increased surface area for energy absorption
Increase wheel performance	Increase wheel performance

INFLUENCE OF CROSS-FEED

LARGE CROSS-FEED	SMALL CROSS-FEED
Increases MMR Increases over grind	Reduce peak-valley dimension

Influence of Cross Feed on
MRR & Surface Finish



Stainless steel slab conditioning

IMPROVING SURFACE QUALITY

Wheel bond grade	Holding abrasive in wheel longer than normal (stable grinding) produces better surface finish
Grinding force	Reducing grinding force improves surface finish
Wheel speed	Increasing wheel speed improves surface finish
Table speed	Increasing table speed improves surface finish
Metal quality	Grinding low tensile materials gives poor finish
Grinding temperature	Reduction of the temperature decreases surface finish

ON-SITE TESTING

Use the Test Request Form found at the back of this Guide or the System Documentation to collect test data.

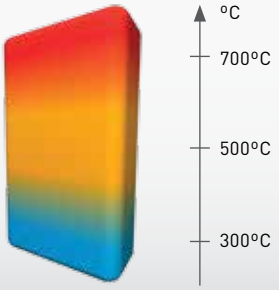
LARGE DIAMETER CUT-OFF (LDCO) WHEELS

Steel cutting requires high performance reinforced wheels to provide a good quality, clean cut and efficient cut rate. Saint-Gobain Abrasives offers a wide range of optimized cutting wheels to meet all requirements, temperatures of cut and material characteristics. Large Diameter Cut-Off wheels (LDCO) are larger than 900mm in diameter and are widely used in the steel market.

INTRODUCTION

The choice of cut-off wheel depends on process variables including the temperature of the material to be cut, material characteristics (type, shape and dimensions) and cut-off machine (power availability and type).

WORKPIECE TEMPERATURE		APPLICATION
Hot cutting	700-1000°C	Steel mills
Warm cutting	300-700°C	Steel mills
Cold cutting	Up to 300°C	Steel mills and finishing shops



MATERIAL CHARACTERISTICS

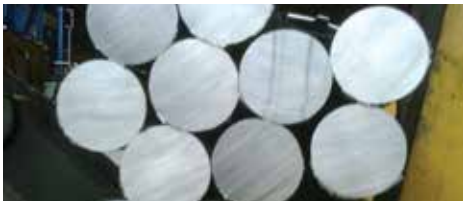
Material type and characteristics influence the choice of wheel specification.
The following material types are commonly found in LDCO applications:

- High alloyed carbon steel (construction steel, bearing steel)
- Low alloyed carbon steel
- Super-alloys Ni-Cr based
- Stainless steel
- Titanium

CUT REQUIREMENTS

Quality: White cut, cut straightness (within tight tolerance).
G-ratio: Life time of the cutting-wheel, dark cut permitted.

Cut requirements can vary depending on the application. Quality of cut is often important when a white cut is required.



White cut (no burns, cut straightness)

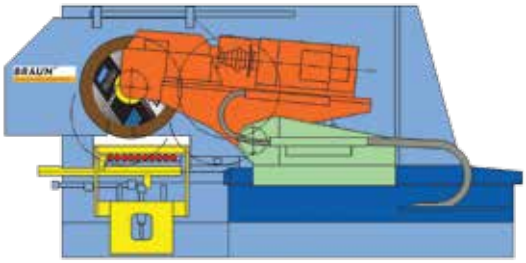
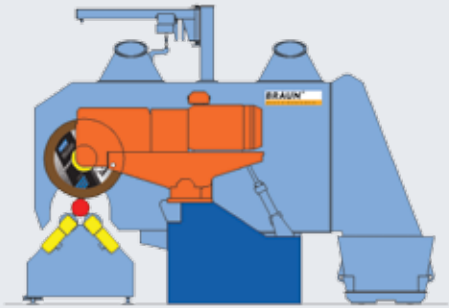
Dark cut (burns, blueing is visible)

TOP TIP

The shape (round, square) and dimensions of the bars to be cut can impact wheel performance and specification. The key parameter is the contact surface (cross section) during cutting.

CUT-OFF MACHINE CHARACTERISTICS

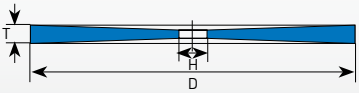
The type of cutting machine is important when selecting wheel specification.
The most common LDCO machines are:

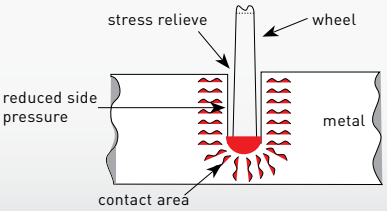
CUTTING-OFF PROCESS	DETAILS
CHOP STROKE CUTTING 	This cutting process is simple and versatile - ideal for single bars. Single or multiple bars can be cut in both cold and hot processes. The contact surface can be reduced by oscillation and/or pendulum movements, this will reduce the power consumption so less power is needed.
TRAVERSE CUTTING 	In this cutting process the workpieces are placed side by side. Several shapes and dimensions can be cut at a variety of temperatures. It's the highest capacity machine.
ROTARY CUTTING / INDEX CUTTING 	Used when cutting workpieces with large diameters. Tubes are rotated continuously (rotary cutting) with the advantage that only the wall of the tube needs to be cut through. Full-faced workpieces are cut in partial cuts whereby the workpiece is fixed during cutting but turned a little after each partial cut (index cutting).

PRODUCT CHARACTERISTICS

All Saint-Gobain Abrasives LDCO wheels are shape 41 (standard ISO 525) with tapered geometry. Taper shape helps the cutting action decreasing heat generation and wheel consumption.

TAPERED SHAPE WHEEL





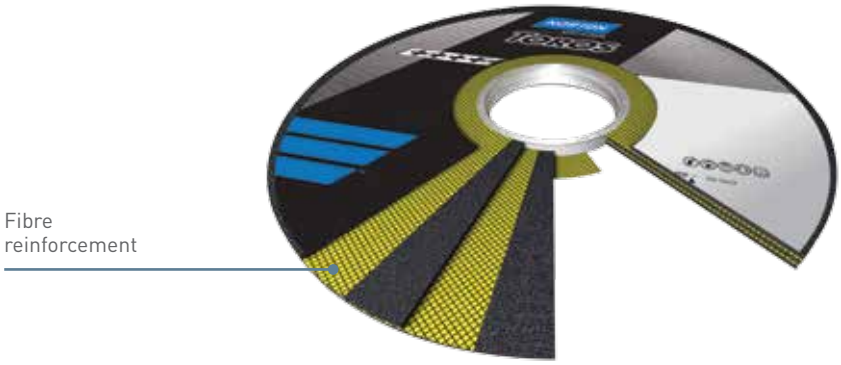
DIMENSIONAL AVAILABILITY

DIAMETER (mm)	THICKNESS RANGE (mm)	BORE (mm)	MOQ
1020	10 to 13.5	80 - 100 - 127 - 152.4 - 203.2	3
1260	11 to 14.5	100 - 127 - 152.4 - 203.2 - 230 - 250 - 280	3
1400	12 to 16	100 - 127 - 152.4 - 203.2 - 230 - 250 - 280 - 304.8	3
1560	13.5 to 18	100 - 127 - 152.4 - 203.2 - 230 - 250 - 280 - 304.8	2
1700	14.5 to 18	100 - 127 - 152.4 - 203.2 - 230 - 250 - 280 - 304.8	2

Other dimensions are available on request.

LDCO wheels are reinforced with a fibre structure to increase mechanical resistance when in use. The reinforcement increases the lateral stress capacity, resulting in higher resistance to breakage. The choice of construction (number and distribution of fibers) is optimized as a function of the type of application and wheel dimensions (diameter and thickness).

Saint-Gobain Abrasives R&D team, in collaboration with Saint-Gobain Technical Fabrics, has developed an engineered reinforcement for cut-off products.



PRODUCT RECOMMENDATION

NORTON TOROS

The Norton Toros range of LDCO wheels is made up of a wide range of specifications for all cutting conditions. Wheel specification is selected based on an analysis of the application process.

Norton Toros manufacturing specification:
Example: 5NZU204VBFQ

ABRASIVE BLEND	GRIT SIZE	COMBINATION	GRADE	BOND
5NZU	20	4	V	BFQ

The following commercial specification is used for wheel marking in compliance with ISO standard 525:

ABRASIVES	GRIT SIZE	COMBINATION	GRADE	BOND SPECIFIC NAME, WHEEL CONSTRUCTION
A - Aluminium oxide (including SG, XG and NQ)	Equal to nominal grit size	Omitted	Equal to nominal grade	Omitted, just BFToros
C - Silicon carbide				
Z - Zirconia (ZF and NZ)				
AZ - Aluminium oxide & zirconia blend				

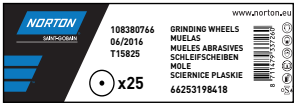
The table below shows an example of conversion for manufacturing specification 5NZU204VBFQ.
Example: AZ20VBFTOROS

ABRASIVE BLEND	GRIT SIZE	COMBINATION	GRADE	BOND
AZ	20	-	V	BFTOROS

TRACEABILITY

All wheels manufactured by Saint-Gobain Abrasives can be identified by unique markings on the blotter and box, containing all production information: material index, batch number, expiry date, wheel number.

Material index (specification) → 66253198418
Batch number (production) → 108380766
Expiry date (storage) → 06/2016
Wheel number → 34
Box code → T15825



ABRASIVE SELECTION

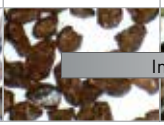
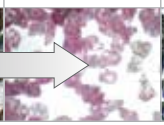
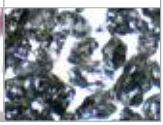
The graph below shows the cost benefit positioning of abrasive blends in a wide range of operating conditions.

Abrasive choice depends on material to be cut and operating conditions.

PRIMARY ABRASIVE GRAINS

CODE	NZ	ZF	Q	O	K
Description	Premium zirconia	Sharpened zirconia aluminium	Doped aluminum oxide	Sintered bauxite	Premium aluminium oxide
Cutting (MRR)	+	+	++	++	+
Wheel Life	+++	++	+	+	++
Surface finish	--	-	++	+	++
					

CONVENTIONAL ABRASIVE GRAINS

CODE	A	U	D	R	C
Description	Fused aluminium oxide	Blocky aluminium oxide	Semi-friable aluminium oxide	Friable pink aluminium oxide	Black silicon carbide
					

ABRASIVE BLENDS

Abrasive grains can be combined to provide optimum results. Abrasive blends can be binary (with two different abrasives) or ternary (with three different abrasives).

BINARY ABRASIVE BLENDS

5	NZ	U
Vol % of 1st abrasive	1st abrasive	2nd abrasive
6	ZF = Zirconium	A = standard AlOx
5	NZ = Norzon	U = blocky AlOx
4		C = black SiC
		D = semi-friable AlOx
		Q = doped AlOx
		O = extruded AlOx
		K = Premium AlOx

Increasing content

TERNARY ABRASIVE BLENDS

5	N	5	Q	U
Vol % of 1st abrasive	1st abrasive	Vol % of 2nd abrasive	2nd abrasive	3rd abrasive
6	ZF = Zirconium	5	A = standard AlOx	U = blocky AlOx
5	NZ = Norzon	4	U = blocky AlOx	D = semi-friable AlOx
4			C = black Silicon carbide	R = pink semi-friable AlOx
			D = semi-friable AlOx	
			Q = doped AlOx	
			O = extruded AlOx	
			K = Premium AlOx	

Increasing content

Abrasive selection for the most common materials in steel mill operations is given below for cold to warm and hot cutting applications.

		MATERIAL TYPE				
		High alloyed carbon steel (contruction steel, bearing steel)	Low alloyed carbon steel	Superalloys Ni-Cr based	Stainless steel	Titanium
Hot Cut	BEST +++++	4NZQ	4ZFU	4NZQ	4ZFO	4ZFC
	BETTER ++++	4ZFU	5ZFU	5Z5QU	4Z50U	5ZFC
	GOOD +++	5ZFU	5ZFU	5ZFU	6ZFU	57AC
Cold-Warm Cut	BEST +++++	4NZQ	4NZU	4N5SD	4NZU	5NZC
	BETTER ++++	5Z5QU	5NZU	5N5QR	5NZU	5ZFC
	GOOD +++	5ZFD	5ZFU	5NZD	5ZFU	57AC

ABRASIVE GRIT SIZE

The table below provides a guide to selecting the grit size according to material type:

	MATERIAL TYPE				
	High alloyed carbon steel (contruction steel, bearing steel)	Low alloyed carbon steel	Superalloys Ni-Cr based	Stainless steel	Titanium
Hot Cut	16	16	20	16	16
Cold-Warm Cut	20	20	24	20	20

Common grit size combinations are:

- 1 = 100% nominal (N) grit size
- 4 = 50% N grit + 50% finer (N-1) grit.
- 0 = standard combination for abrasive blend containing ZF/NZ coarser grain.

Example: 20-0-->ZF/NZ in grit 16, diluent in grit 20 and 24 (50% each).
Example: 16-4= 50% grit 16 + 50% grit 20

BOND TYPE

Bond type selection depends mainly on workpiece temperature and application requirement.

BOND TYPE	DESCRIPTION
BF H (Hot)	Specific bond for hot cutting applications
BF P (Performance)	Bond for cold / warm applications where longer wheel life is required (high G ratio)
BF M (Medium)	Bond for cold / warm application balances wheel life & cut-quality
BF Q (Quality)	Bond for cold applications suitable for excellent cut-quality (white and straight cut)

		MATERIAL TYPE				
Application	Selection criteria	High alloyed carbon steel (contruction steel, bearing steel)	Low alloyed carbon steel	Superalloys Ni-Cr based	Stainless steel	Titanium
Hot Cut	Longest wheel life	BFH	BFH	BFH	BFH	BFH
Cold	Cut quality	BFQ	BFQ	BFQ	BFQ	BFQ
Cold-Warm Cut	Balance of wheel life and cut quality	BFM	BFP	BFM	BFM	BFQ
	Longest wheel life	BFP	BFP	BFP	BFP	BFQ

WHEEL GRADE (HARDNESS) RECOMMENDATION

	MATERIAL TYPE				
Application	High alloyed carbon steel (contruction steel, bearing steel)	Low alloyed carbon steel	Superalloys Ni-Cr based	Stainless steel	Titanium
Hot Cut	U - W	U - W	T - V	V - W	T
Warm Cold	W	V - X	V - W	V - X	R
Cold Cut	U - W	U - W	T - V	V - W	P

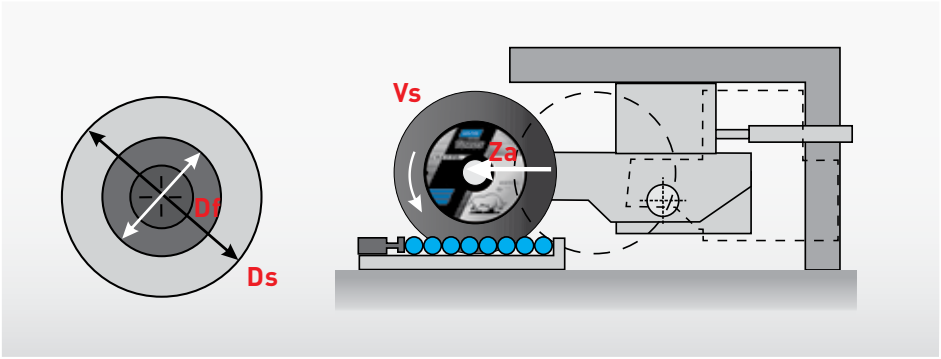
PRODUCT SELECTION GUIDE

The specifications provided below are typical of mixed material configurations found in most steel mill applications and are valid for traverse machine systems.

APPLICATION	SELECTION CRITERIA	MATERIAL TYPE	WHEEL SPECIFICATION
Hot Cut	Wheel life	Stainless steel	4ZFO20VBFH
	Wheel life	High alloyed carbon steel	4ZFU20VBFH
	Wheel life	Low alloyed carbon steel	4ZFU164VBFH
Warm Cut	Cut quality / Wheel life	High alloyed carbon steel (contruction steel, bearing steel)	5Z5QU201VBFP
	Cut quality / Wheel life	Stainless steel	5NQU164VBFP
	Cut quality / Wheel life	Low alloyed carbon steel	4ZFU164VBFP
Cold Cut	Wheel life	High alloyed carbon steel	5Z5QU20VBFP
	Wheel life	Low alloyed carbon steel	4ZFU20VBFP
	Cut quality / Wheel life	Stainless Steel	5NZU201WBFM
	Cut quality	Superalloys Ni-Cr based	5N5QR204VBFQ
	Cut quality	High alloyed carbon steel	5Z5QU204VBFQ
	Cut quality	Low alloyed carbon steel	4ZFU204VBFQ
	Cut quality	Stainless steel	5NZU204VBFQ

APPLICATION GUIDELINES

The diagram below shows an example of a traverse cutting-off application with main operating parameters highlighted.



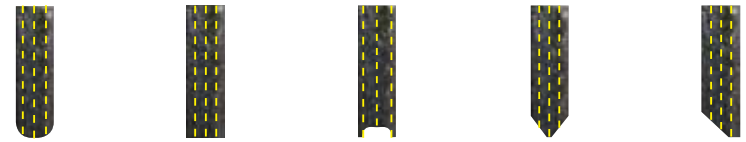
The table below shows the common range values for these operating parameters.

Peripherical speed **(Vs)**	63 to 100 m/s
Flange Diameter **(Df)**	1/3 wheel LDCO diameter (Ds)
Infeed **(Za)**	12-30 cm^2/s for hot cutting
	8-25 cm^2/s for warm cutting
	5-15 cm^2/s for cold cutting

PROFILE CHARACTERISTICS

Wheel profile is influenced by internal fiberglass, layer & working par.

- Square/Light Convex: most common for correct application
- Concave: most common when mild specifications are used with light pressure on the workpiece. Helps to maintain straight cutting.
- Pointed: wheel is too hard cutting or feed rate is too slow
- Chisel: results from incorrect machine torque or from incorrect layer distribution inside the wheel.



Convex Square Concave Pointed Chisel

ON-SITE TESTING

Use the Test Request Form found at the back of this Guide or the System Documentation to collect test data.

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	SUGGESTED CORRECTION
Poor wheel life (Gratio)	Specification too soft	Harder bond/grade
	Grit too fine	Coarser grit
	Wheel too thin	Increase wheel thickness
	Grain too friable	Use more durable abrasive blend
Poor cut rate (MRR)	Insufficient power	Use harder grain and/or finer grit
	Specification too hard	Add a semi-friable diluent
	Abrasive too durable	Use softer or thinner wheel
	Abrasive too coarse	Use finer grit
Poor cut quality: not square cut	Wheel too hard	Use softer wheel
	Work piece not clamped properly	Check clamping sytem
	Miss-aligned spindle bearings	Check machine
	Insufficient feed rate	Increase feed rate
Poor cut quality: workpiece burn	Wheel too hard	Use softer grade wheel
	Grit too coarse	Use finer grit spec
	Wheel speed too high	Decrease rotational speed
Poor cut quality: workpiece burrs	Grit too coarse	Use finer grit
	Specification too hard	Go to a softer spec

NOTES

ROLL GRINDING

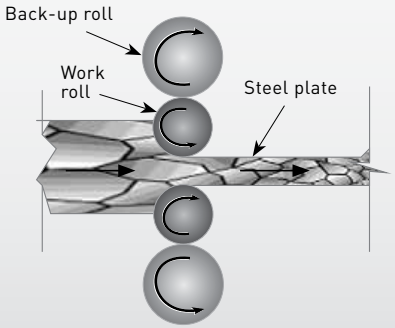
Grinding wheels are used in the regrinding and production of rolls in the steel, aluminium, brass, copper, paper and textile industries. The main consumption of rolls is in the primary steel industry where the rolling process is most commonly used to produce coils and plates to the required thickness and surface finish, starting from slabs. The material type and dimensions of rolls differ depending on the rolling application. Saint-Gobain Abrasives offers a wide product portfolio, providing cost benefits for grinding all roll materials (including HSS) in different applications.

INTRODUCTION

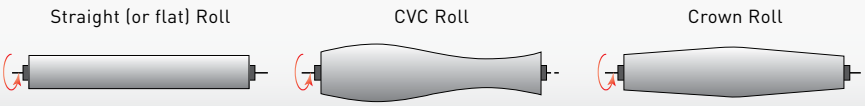
Steel slabs are rolled in Hot Rolling Mills (HRM) or Cold Rolling Mills (CRM) to achieve the desired finish and dimension. For both hot and cold applications, rolls can be divided into two different families: Work rolls and Back-Up rolls.

Work rolls are used for rolling the steel, designed to sustain the high pressure and temperature (especially on HRM) and to impart the required surface finish.

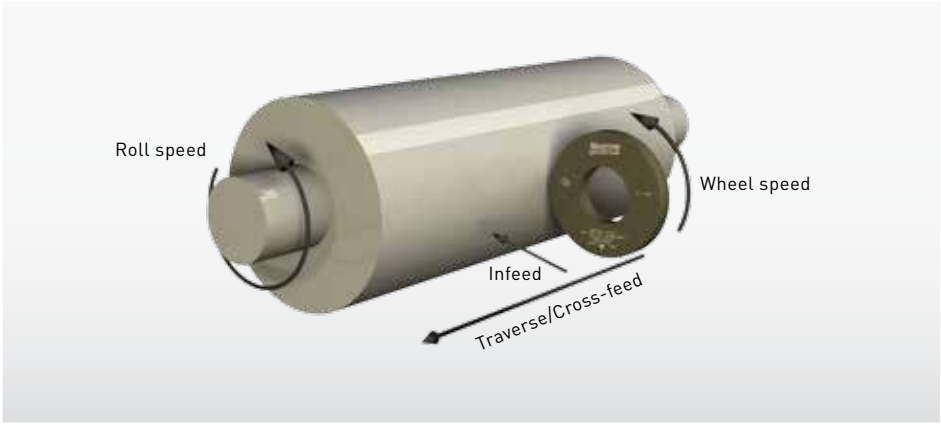
Back-up rolls support the tremendous pressure exerted on the work rolls. They are not in direct contact with the steel plate.



Rolls have different dimension, material and application requirements. Depending on the stage of the laminating process, a specific type of surface finish and roll shape is required:



Rolls degrade during the rolling process and can become scratched, cracked, lose their shape or even melt the steel. They are regenerated by a cylindrical, high precision grinding process (roll grinding).



Most roll grinding wheels are large in diameter (700-1080mm) and thickness (50-150mm). Roll grinding wheels are available in the following shape types (ISO standard 525):

- Type 01 = straight wheel
- Type 05 = single recess wheel
- Type 07 = double recess wheel
- Type 21 = wheel relieved on both sides

Roll grinding wheels are made from Aluminum Oxide and Silicon Carbide abrasive, including ceramic grain, combined with a resinoid bond. Grit size ranges from 24 to 220 with grades F to L most common.

The application is always carried out wet, using mostly emulsion with 3-5% water soluble oils (WSO).

TOP TIP

Norton Vortex and Norton Quantum wheels provide very high performance (high MRR and wheel life) in steel mill grinding operations.

PRODUCT CHARACTERISTICS

DIMENSIONAL AVAILABILITY

Wheels for roll grinding are available in the most common dimensions:

Diameter (mm)	BORE (mm)												Thickness range (mm)	MOQ
	152 152,4	179 185	203 203,2	254 280	304,8 305	330 335	355 355,6	380 400	406	407 407,2	450 457	481 508		
600-610	■	■	■	■	■	■	■	■	■	□	□	□	25-100	2
615-660	■	■	■	■	■	■	■	■	■	□	□	□	25-150	2
665-700	□	■	■	■	■	■	■	■	■	□	□	□	25-80	2
705-760	□	□	■	■	■	■	■	■	■	□	□	□	25-150	2
765-810	□	□	■	■	■	■	■	■	■	■	■	■	30-260	1
815-910	□	□	■	■	■	■	■	■	■	■	■	■	30-160	1
915-945	□	□	■	■	■	■	■	■	■	■	■	■	30-120	1
950-1015	□	□	□	□	■	■	■	■	■	■	■	■	35-130	1
1020-1050	□	□	□	□	■	■	■	■	■	■	■	■	35-150	1
1060-1080	□	□	□	□	■	■	■	■	■	■	■	■	40-150	1

KEY: ■ Available □ Not available

Please contact Product Management for other products not listed.

WHEEL MARKING

Norton grinding wheel manufacturing specification: Example: 3NQJ364JBQN24

The table below shows an example of wheel marking conversion from the manufacturing code: 3NQJ364JBQN24 to the commercial specification:

	ABRASIVE TYPE	GRIT SIZE	COMBINATION	GRADE	BOND
Manufacturing	3NQJ	36	4	J	BQN24
Commercial	NQJ	36	-	J	BQN

All Saint-Gobain Abrasive's wheels are marked in compliance with the International Standard ISO 525.

IDENTIFICATION & TRACEABILITY

Each wheel provided by Saint-Gobain Abrasives is identified by a unique marking containing all information about the production of the wheel.

Material index (specification) → 66253328671
Batch number (production) → 108331179
Expiry date (storage) → 07/2016

PRIMARY ABRASIVE GRAINS

Different grain qualities are available to meet various grinding needs.

CODE	NQ	XG	SG	TG	VORTEX/38AA
Description	Engineered microstructure ceramic grain	Ceramic grain, weak shape	Ceramic grain, strong shape	Extruded ceramic grain	Patented grain technology
Cutting (MRR)	+++	++	++	+++	++
Wheel Life	+++	++	+	++	++
Surface finish	++	++	++	+	+++
					

+ Denotes performance rate

CONVENTIONAL ABRASIVE GRAINS

CODE	M	R	J	G
Description	Monocrystalline brown fused aluminum oxide (AlOx)	Pink aluminum oxide (AlOx)	White aluminum oxide (AlOx)	Green silicon carbide (SiC)
				

ABRASIVE BLENDS

Abrasive blends can be binary (2 abrasives) or ternary (3 abrasives). Combinations can be made to achieve optimum results. Grain combinations are codes containing a series of digits:

BINARY ABRASIVE BLENDS		
4	NQ	G
↓	↓	↓
Vol % of 1st Abrasive	1st Abrasive	2nd Abrasive
2	SG	C = Black SiC
3	XG	G = Green SiC
4	NQ = Quantum	A = Semi-friable AlOx
5		J = White AlOx
6		R = Pink AlOx
Increasing content		M = Mono-crystalline AlOx

In binary abrasive blend, if white aluminium oxide is the diluent, J can also be omitted.
Example: 4NQ= blend of NQ and white aluminium oxide.

TERNARY ABRASIVE BLENDS			
4	NQ	A	G
↓	↓	↓	↓
Vol % of 1st Abrasive	1st Abrasive	2nd Abrasive	3rd Abrasive
2	NQ = Quantum	C = black SiC	C = black SiC
3	SG	G = green SiC	G = green SiC
4	XG	A = Semi-friable AlOx	M = Mono-crystalline AlOx
5		J = White AlOx	
6		M = Mono-crystalline AlOx	
Increasing content			

GRIT SIZE COMBINATION

54 4

The grit size combination is the nominal grit size and the combination code:
Common grit size combinations are:

1 = 100% nominal (N) grit size

2 = 1/3 coarser (N-1) grit + 1/3 N grit + 1/3 finer (N+1) grit

3 = 1/4 (N-1) grit + 1/4 N grit + 1/4 (N+1) grit + 1/4 (N+2) grit

4 = 50% N grit + 50% (N+1) grit.

Example shown in below table for grit 54, combination 4:

	COMBINATION			
NOMINAL GRIT	1 (100%)	2 (33%-33%-33%)	3 (25%-25%-25%-25%)	4 (50%-50%)
54	54	46-54-60	46-54-60-70	54-60

The grit size is measured in Mesh. The coarser the grain, the higher the MRR (Material Removal Rate) and the G-Ratio (wheel efficiency), the rougher (higher Ra) the roll surface.

ABRASIVE SELECTION GUIDE

General considerations when selecting the abrasive:

- Silicon carbide grinds very ductile materials
- Aluminium oxide and silicon carbide grind high alloyed steel (HiCr – 8/12%Cr)
- Aluminium oxide grinds high tensile material like forged steel
- Silicon carbide increases MRR; aluminium oxide improves wheel life
- Add SG, XG, NQ (premium ceramic grains) when target is higher MRR and Gratio
- Saint-Gobain Abrasive's ceramic grains are ranked by increasing sharpness and cutting efficiency: SG, XG, NQ

The following section provides a recommendation of abrasive type, grit size and bond selection, depending on the application.

WORK ROLL: HOT ROLLING MILLS

In Hot Rolling Mills (HRM), grinding requires fast metal removal, surface finish is not as critical as in cold rolling mills. The work roll is 600-800mm in diameter in strip mills, and up to 915mm for plate. The length of the roll ranges from 1600-3400mm. Grit size used usually ranges from 30 to 46 to achieve the surface finish required. Roll material from first to last train: ICDP – HighCr – semi-high speed steel (HSS).

	CAST IRON OR ICDP	HIGH CR STEEL	HIGH CR CAST IRON	HSS
BEST +++++	4NQG	4NQAG	4NQG	4NQG
BETTER ++++	3XGG	3XGAG	3XGG	3XGG
GOOD +++	39C	1XGAC	1XGG	2XGG

Standard grit size	Surface quality (Ra)
30	3.5 - 1.3
36	1.1 - 0.9
46	1 - 0.7

TOP TIP

Usually green silicon carbide is used for grinding wheels used in HRM. Black silicon carbide can replace green for stiff machine systems. In abrasive blend description, it is indicated by "C" replacing "G" (e.g.: 3NQG-->3NQC), this is a more economical blend.

For High Cr Steel, the following blend can be used as an alternative to 4NQAG:
5T5XM= TG grain (ceramic extruded grain) + XG grain + Monocrystalline aluminium oxide.

WORK ROLL: COLD ROLLING MILLS

In Cold Rolling Mills (CRM), less material is removed from the roll but surface finish is critical (typical Ra of <0.4 µm). The work roll ranges in diameter from 300 to 760mm. Length is usually 2500mm. Grits 46-150 are used to achieve a satisfactory surface finish. Roll material from first to last train: forged steel and high speed steel (HSS).

	FORGED STEEL LOW-MED CR 2-5%)	HIGH CR STEEL	HSS
BEST +++++	2NQ,2NQR	2NQ,2NQR	4NQG
BETTER ++++	38AA (Vortex)	G3A (Vortex)	2XGG
GOOD +++	23A, 40A, 32A	38A, 40A, 23AG	23AG

The table below shows grit size recommendation depending on the surface finish required for standard and equivalent Vortex grits.

Standard grit size	Vortex grit size	Surface quality (Ra)
46	46	1-0.7
60	60	0.7-0.5
80	80	0.5-0.3
90		0.25-0.4
100	100	0.2-0.3
120		0.2
150-180	120	0.15

BACK-UP ROLL: HOT AND COLD ROLLING MILLS

The back-up rolls deliver and support the pressure to the work roll. They are larger in diameter than work rolls (up to 1600 mm in diameter). Rolls are classified either as cast or forged. Back-up rolls are usually made from 2 to 5 % chromium steel. In some cases double poured iron and high speed steel (HSS) are used.

Back-up rolls are not ground as often as work rolls, but generally significantly more material (as much as 2 mm on diameter) is removed.

Grit size usually ranges from 30 to 46 to achieve the surface finish required.

	FORGED STEEL LOW-MED CR 2-5%)
BEST +++++	2NQ,2NQR
BETTER ++++	38AA (Vortex)
GOOD +++	23A, 40A, 32A

Standard grit size	Vortex grit size	Surface quality (Ra)
30	N/A	3.5 - 1.3
36	46	3 - 1
46		2 - 0.7

TOP TIP

Vortex codification: 38AA: patented grain technology;
G3A: Blend patented grain and green silicon carbide

Other: 23A: Blend mono crystalline and semi-friable aluminium oxide
23AG: Blend mono crystalline, semi-friable aluminium oxide and green silicon carbide

BOND SELECTION GUIDE

Different bond systems are available depending on the application type and roll properties. Bond selection is also linked to abrasive type. The table below shows the bond type used with the right abrasive compatibility.

	BOND TYPE	DESCRIPTION	BENEFITS	ABRASIVE COMPATIBILITY
BEST +++++	BQN24	Optimized bond for new generation ceramic grain Quantum	Higher MRR and G Ratio	Abrasive blends with Norton Quantum e.g.: 4NQG
BETTER ++++	B491	Optimized bond for porous and permeable structure (Vortex)	Efficiant coolant access to the grinding zone	38AA (Vortex)
GOOD +++	B24, B12	Organic bonds for conventional and standard ceramic grains (SG, XG)	Versatile bond B24 : HRM B12 : CRM	For all other abrasive blends excluding Vortex and Quantum

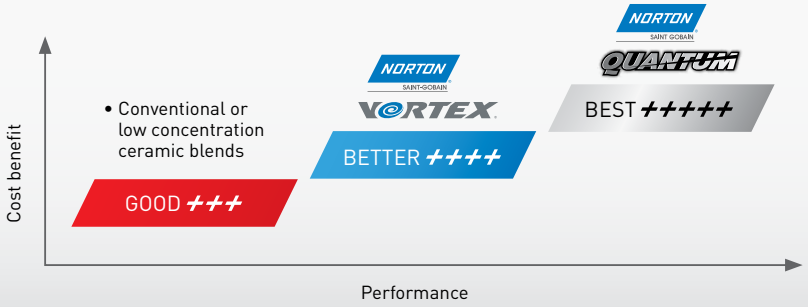
Shellac bond (E6) is also available if very soft grinding behaviour is needed (especially in CRM to achieve a very fine surface finish).

GRADE SELECTION

The table below shows the wheel hardness (grade) selection based on roll hardness for different bond types. The coloured rectangles show the typical hardness range depending on the roll application type, i.e. hot and cold work rolling and back-up rolls.

Application			ROLL HARDNESS				WHEEL HARDNESS	
			Rockwell (HRC)	Vickers (HV)	Brinell (HB)	ShoreC	Bond Type Vortex (B491)	Bond Types B12/24/BQN24
		Back-up rolls	41	400	379	55	H, I	K, L, M
			42	420	397	57		
			44	440	415	59		
			46	460	433	62		
			47	480	452	64		
			48	500	471	66		
			50	520	488	67		
	Work roll-hot steel mill		51	540	507	69	F, G	I, J, K
			52	560	525	71		
			53	580	545	72		
			54	600	564	74		
			55	620	584	75		
Work roll-cold steel mill			56	640	601	77	E	H, I
			57	660	620	79		
			59	680	638	80		
			59	700		81		
			60	720		83		
			61	740		84	D	G, H
			62	760		86		
			63	780		87		
			64	800		88		
			64	820		90	C	F
			65	840		91		
			66	860		92		
			66	880		93		

The graph below shows the cost versus performance positioning of different Norton wheel specifications.



PRODUCT SELECTION GUIDE

Below is the product selection guide for most common applications - use only for reference, and review grade / grit size selection based on recommendation given in the next sections. Contact product manager or application engineer for specific request.

Hot Mills - Work Roll

	CAST IRON OR ICDP	HIGH CR STEEL	HIGH CR CAST IRON	HSS
BEST +++++	4NQG36JBQN	4NQAG36JBQN	3NQG36JBQN	4NQG46JBQN
BETTER ++++	3XGG36JB24	3XGAG36JB24	3XGG36JB24	3XGG46JB24
GOOD +++	39C36JB24	1XGAG36JB24	1XGG36JB24	1XGG46JB24

Cold Mills - Work Roll

	FORGED STEEL LOW-MED CR 2-5%)	FORGED STEEL HI CR >8%	HIGH ALLOYED STEEL OR HSS
BEST +++++	2NQ60HBQN	2NQR70IBQN	4NQG70IBQN
BETTER ++++	38AA60FB491	G3A60FB491	2XGG70B24
GOOD +++	32A80HB24	38A70MB24	23AG60HB24

Back-up Roll

	FORGED STEEL LOW-MED CR (2-5%)
BEST +++++	2NQ36HBQN
BETTER ++++	38AA46EB491
GOOD +++	32A36HB24

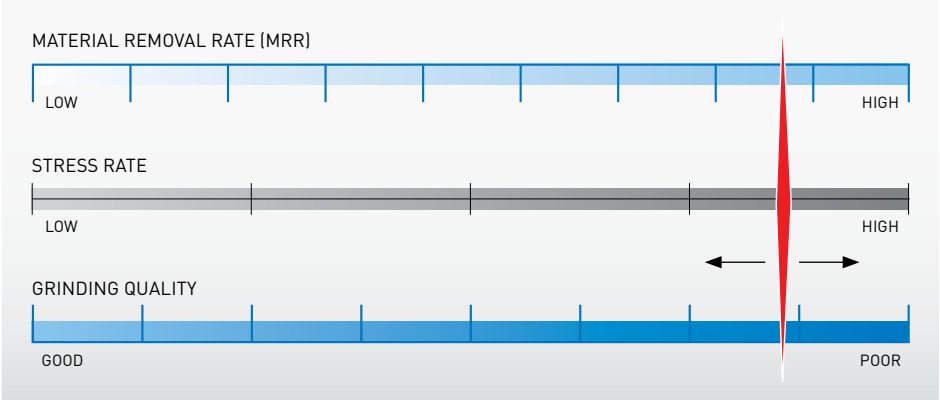
TOP TIP

For the best results use new Quantum specification with optimized open-structure. Contact Product Management for specification.

APPLICATION GUIDELINES

In roll grinding applications, the roll diameter is larger than the wheel diameter. The grinding result mainly depends on the stress between the wheel and roll at the point of contact.

Grinding parameters influence MRR, WWR (wheel wear rate), power absorbed (P) and surface quality (Ra).



- Roll surface quality, roughness and tight geometrical tolerances
- Any increase in stress between the wheel and the roll increases MRR
- Any reduction in stress between the roll and the wheel improves grinding quality

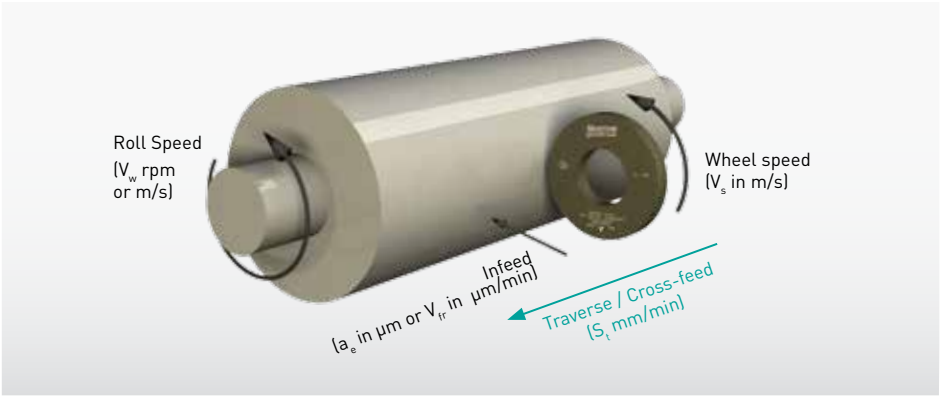
OPERATIONAL FACTORS EFFECTING GRINDING

The stress in the grinding zone depends on:

- Wheel speed (V_s measured in m/s)
- Roll speed (V_w measured in rpm or m/s)
- Cross-feed or traverse rate (S_t measured in mm/min),
- Sequential Infeed rate (a_e µm) or continuous infeed rate (V_{fr} µm/min)
- Coolant application, type and flow.

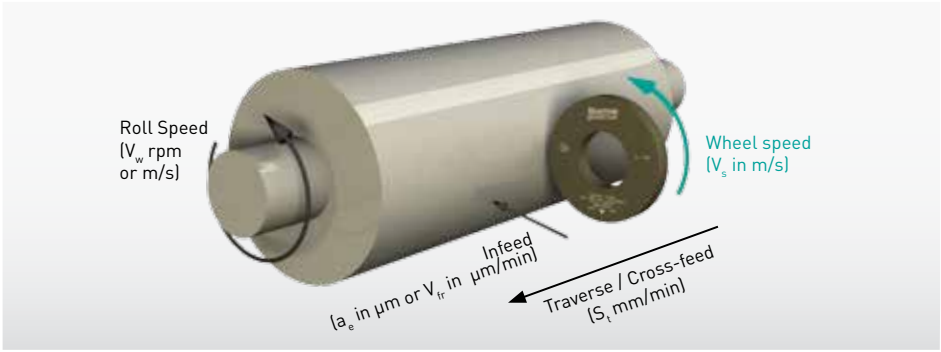
Changing the parameters affects the grinding quality, productivity and the total grinding cost.

TRAVERSE RATE



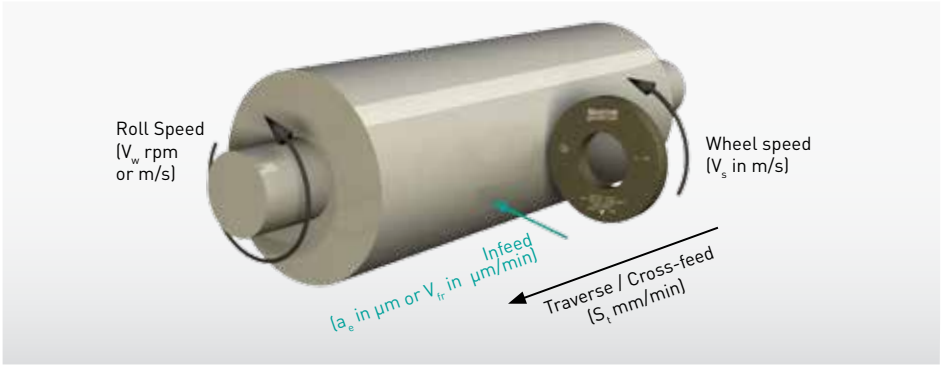
SLOW (< 1 000 mm/min)	FAST (> 1 000 mm/min)
Decreased wheel wear	Increased MRR
Lower amps / power	Shorter wheel life
Improved finish	Increased productivity
Better roll surface quality	Higher productivity

WHEEL SPEED



SLOW (20 – 35 m/s)	FAST (36 - 48 m/s)
Lower amps/power	Increased MMR
Less chatter	Decreased wheel wear
	Higher Gratio / wheel life
Better roll surface quality	Higher productivity & lower abrasive cost

INFEED/INFEED RATE



LOW (<25µm)	HIGH (>50µm)
Improved surface finish	Increased MMR
Decreased wheel wear	Wheel acts softer
Lower amps / power	Higher productivity
Better roll surface quality	Higher productivity

CUT RATIO

Cut Ratio (CR) is the wheel speed (Vs) in m/s divided by the roll speed (Vw) in m/s (CR = Vs/Vw). Increasing wheel speed (Vs) and/or decreasing roll speed will increase the cut ratio.

CR between 45 and 60 is ideal for high MRR. Reduce CR less than 40 for better surface finish and below 30 to eliminate chatter.

CUT WIDTH

Cut width or overlap (Wc) is the amount of wheel overlap that takes place in one revolution of the roll.

Wc (mm/rev) = T Traverse rate (mm/min)/roll speed (rpm).

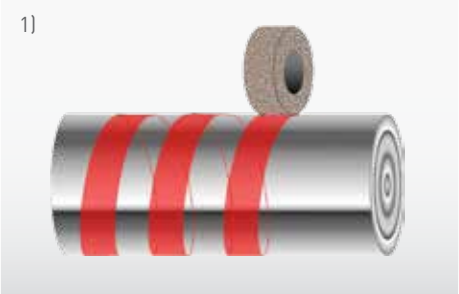
The smaller the Wc the better the finish, but the lower the MRR.

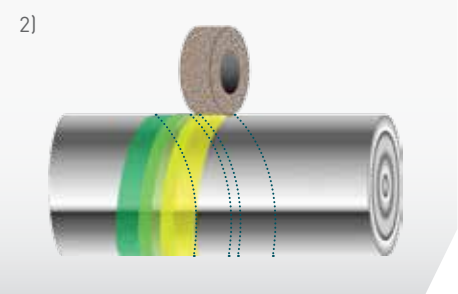
Having a Wc close to 67% of the wheel thickness is ideal for roughing.
Never exceed 75% of the wheel width (tolerances won't be kept and rough finish).

The diagrams below show two examples of overlap conditions.

1) Wc'<0% / no overlapping: some parts of the roll will not see the wheel during the pass. This happens when the roll turns too slowly in comparison with traverse speed.

2) Wc'~33% partial overlapping: 1/3 of the surface of the roll sees the wheel twice during 1 pass. The roll turns once turn while the wheel moves 2/3 of its width.





GRINDING FLUID (COOLANT AND LUBRICANT)

Main purposes of the grinding fluid are:

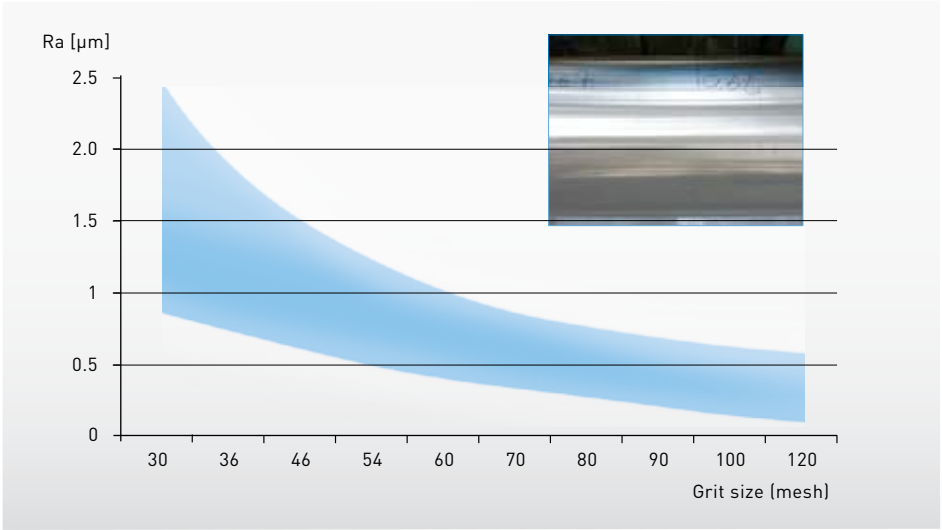
- Lubrication: helps to remove chips, reduces friction and grinding machine degradation.
- Coolant effect: keeps the work temperature low, preventing heat dissipation through the part (cracks) and in the wheel (bond degradation).

Grinding fluid requirements:

- Flow rate is recommended at ~4 litres/min/kW with laminar flow
- Coolant speed from nozzle = wheel surface speed
- Pressure should be between 5 and 9 bars
- Nozzle dimensions cover complete wheel face (w = width of wheel)
- pH of grinding fluid should be less than 10, above pH10 organic bonds are degraded.

GRIT SIZE

- Coarser grits yield longer wheel life and increase MRR (productivity).
- Finer grit sizes improve surface finish and are also required to grind hard and tough materials like HSS.
- Abrasive type and bond type also influence surface finish.

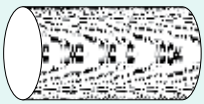
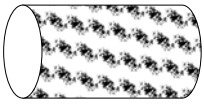
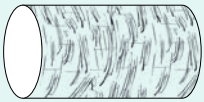


SUMMARY

TECHNICAL OUTPUT	WHEEL SPEED		ROLL SPEED		CROSS-FEED		INFEED	
	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
MRR	↓	↑	↑	↓	↓	↑	↓	↑
WWR	↑	↓	↓	↑	↓	↑	↓	↑
Power	↓	↑	↑	↓	↓	↑	↓	↑
Chatter	↓	↑	0	0	↓	↑	↓	↑
Surface Finish (Ra)	0	0	↑	↓	↓	↑	↓	↑

KEY: ↑ Negative effect ↑ Positive effect ↑ Power increase or decrease 0 No effect

TROUBLESHOOTING

PROBLEM	DIAGRAM	POSSIBLE CAUSE	SUGGESTED CORRECTION
Poor quality finish		Contaminated coolant	Filter coolant and clear regularly
		Grit collection in guard	Clean and flush inside guard periodically
		Traverse too fast	Reduce traverse rate
		Poor wheel dressing	Dress correctly before finish operations - use plenty of coolant while dress
		Wrong cut ratio	Reduce cut ratio
		Infeed too high	Reduce infeed for last passes
Longitudinal scratches		Spindle bearing failure	Check bearing for quality and aligment
		Grinding wheel surface not regular	Check wheel surface and set a dressing phase
V shapes defect		Dirty coolant	Clean coolant frequently
			Use an effective filter
		Dresser not properly fixed	Fix dresser properly
		Wheel too soft	Change specification or increase wheel speed
Feed lines		Not dressing properly	Check dressing parameters
		Wheel edges too sharp	Break/chamfer the edges
		Wheel not in axis with its centre	Check the axis passing between the centering points
		Incorrect overlap ratio	Decrease wheel speed &/or slow down traverse rate on finishing passes. Reduce overlap ratio (<75%)

PROBLEM	DIAGRAM	POSSIBLE CAUSE	SUGGESTED CORRECTION
Chattering		Spindle bearing failure	Check bearing for quality and aligment
		Vibrations from machine system	Maintenance
		Umbalanced wheel/flange coupling	Check the imbalance
		Roll speed too fast	Reduce roll speed until vibration stops
		Inadequate lubrication of rolls neck	Maintenance
		Wheel too hard	Reduce wheel speed; use softer grade
Burn & cracks		Roll speed too slow	Increase roll RPM
		Wheel speed too high	Decrease wheel speed
		Contact time too long	Increase traverse feed
		Stress on the contact area too high	Decrease wheel infeed and traverse speed
		Wheel too hard	Reduce wheel speed; use softer grade
		Wheel needs dressing	Dress wheel open with plenty of coolant
		Coolant not properly oriented	Direct better the coolant flow
		Not enough coolant flow	Increase coolant flow
		Poor wheel dressing	Dress wheel open with of coolant

ON-SITE TESTING

Use the Test Request Form found at the back of this Guide or the System Documentation to collect test data.

TEST REQUEST FORM

GENERAL INFORMATION	
Customer name	
Country	
Distributor	
Sales responsible	

MACHINE			
Manufacturer			
Type			
Year/condition			
Spindel Power			kW
Max grinding pressure/force /Mass	PSI	N	kg
Max wheel speed		m/s	RPM
Constant RPM	Yes / No		

WORK PIECE	
Type (slab/billet/roll/bar/ sheet/tube/ingot)*	
Shape (round/square/other)*	
Dimensions	mm

QUALITY / TEMP		
Construction steel	%	°C
Steel, low-alloyed	%	°C
Steel, high-alloyed	%	°C
Stainless austenitic	%	°C
Stainless ferritic	%	°C
Titanium	%	°C
Other...	%	°C
Domain of application (HRM, CRM)		%
Roll Manufacturer		
Type of roll	Work	Back-up

GRINDING WHEEL			
Dimension			
Shape (01 / 05 / 07 / 21)*			
Incumbent specification			
Reinforcement design	number	dimension	position of webs
Price			€
Consumption			wheels per month / wheels per year*
Stub diameter			mm
Specification proposal			

ROLL MATERIAL TYPE (please indicate hardness HRC/Shore C/HV/HB)		
ICDP	%	ø x L
Cast Iron	%	ø x L
HSS	%	ø x L
Semi HSS	%	ø x L
High Cr Steel	%	ø x L
Forged steel low/med Cr	%	ø x L
Forged steel high Cr (>8%)	%	ø x L
Other...	%	ø x L

GRINDING PARAMETERS (if multiple cycles, please complete data for each cycle)			
Traverse or table speed	m/min for BZZ or mm/min for Roll grinding		
Crossfeed/Index	mm		
Sequential infeed	mm/pass		
Continuous infeed	mm/min		
Grinding pressure /force /Mass	PSI	N	kg
Grinding power	kW	A	%
Wheel speed	m/s		
Work piece speed	RPM	m/min	
Grinding head angle	°	90°: Wheels perpendicular to the table	

REQUIREMENT				
Surface roughness (Rz / Ra / Rmax)*	µm			
Grinding ratio	kg/kg	kg/dm³	dm³/dm³	dm²/dm²
MRR	kg/h	cm²/s	cm³/s	
Grinding time				
Other...				

KEY:

Black = Common
Orange = BZZ
Green = LDCO
Blue = Roll grinding

* Please select correct value

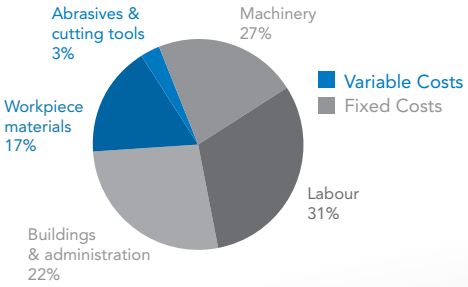
NOTES

PSP process solutions program

Typical cost reductions

On average abrasives and cutting tools only account for about 3% of total manufacturing budgets. Norton Quantum, Toros and BZZ products optimised with Norton's proprietary PSP (process solutions program) helps to optimise your total cost and improve your productivity.

For information on how to achieve the greatest overall cost savings, see the example below or go to **www.saint-gobain-abrasives.com/psp-eu.aspx**.



Decreasing the price of abrasives
A 30% price reduction will only reduce costs per part by 1%.

Increasing the life of abrasives
Even a 50% increase in product life will only reduce costs per part by 1%.

Increase overall productivity through PSP
With a 20% decrease in cycle time per part there will be a reduced total cost per part of more than 15%.

www.norton.eu

Saint-Gobain Abrasifs
European Headquarters
Rue de l'Ambassadeur - B.P.8
78 702 Conflans Cedex
France

Tel: +33 (0)1 34 90 40 00
Fax: +33 (0)1 39 19 89 56